

SECTION II

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INTRODUCTION

Some soil properties may be of special interest to engineers because of their effect on the construction and maintenance of roads, pipelines, foundations, and structures of many types. Properties such as permeability, compaction characteristics, plasticity, depth to water table and bedrock, soil drainage, and shrink-swell potential are important in making land use decisions, planning farm practices, selecting project locations, and determining the suitability of soils for certain activities. Much of this information can be found in the local soil survey.

Soil properties relating to engineering interpretations are determined by field examination of the soils and by laboratory index testing of some benchmark soils. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils. Pertinent soil and water features also are provided in this subsection.

This subsection includes the following discussions and tables:

- Engineering Index Properties
- Physical and Chemical Properties
- Water Features
- Soil Features
- Water Management

Also included as a part of this subsection is the California NRCS Irrigation Guide.

While the information provided in the soil survey and California NRCS Irrigation Guide may be useful, it does not eliminate the need for sampling and testing at the site.

Other information regarding soil intake characteristics, available water capacity, and irrigation soil tables may be found in the California NRCS Irrigation Guide.

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ENGINEERING INDEX PROPERTIES TABLE

General

This table gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey areas. Most soils have layers of contrasting properties within the upper 5 to 6 feet. Information in this table includes depth, USDA texture, Unified and AASHTO Classification, rock fragments larger than 3 inches, percentage passing designated sieves, liquid limit, and plasticity index.

Properties

DEPTH to the upper and lower boundaries of each layer is indicated.

TEXTURE is given in the standard terms used by the USDA. The terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. (Textural terms are defined in Chapter 4, *Soil Survey Manual* or in the glossary of most soil survey reports.) If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

UNIFIED CLASSIFICATION SYSTEM classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content.

AASHTO CLASSIFICATION is the system adopted by the American Association of State Highway and Transportation Officials. It classifies soils according to those properties that affect roadway construction.

ROCK FRAGMENTS, 3 to 10 inches and greater than 10 inches in diameter, are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

PERCENTAGE (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200, have openings of 4.76, 2.00, 0.420, and 0.074 millimeters,

respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

LIQUID LIMIT AND PLASTICITY INDEX (Atterbery limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area, or from nearby areas, and on field examination.

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PHYSICAL AND CHEMICAL PROPERTIES TABLE

General

This table shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils. Information in this table includes depth, percent clay, moist bulk density, permeability, available water capacity, soil reaction, salinity, shrink-swell potential, K and T erosion factors, wind erodibility group, and percent organic matter.

Properties

DEPTH to the upper and lower boundaries of each layer is indicated.

CLAY (percent) as a soil separate, or component, consists of mineral soil particles that are less than 0.002 millimeters in diameter. The estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

MOIST BULK DENSITY is the weight of soil (oven-dry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. The estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter.

PERMEABILITY refers to the ability of a soil to transmit water or air. The estimates indicate the rate of movement of water through the soil when the soil is saturated. They are based on soil characteristics in the field, particularly structure, porosity, and texture.

AVAILABLE WATER CAPACITY refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage in each major soil layer is stated in inches of water per inch of soil. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone.

SOIL REACTION is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory.

SALINITY is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at typical sites of non-irrigated soils.

SHRINK-SWELL POTENTIAL is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil.

EROSION FACTOR K indicates the susceptibility of a soil to sheet and rill erosion by water.

EROSION FACTOR T is an estimate of the maximum average annual rate of soil erosion that can occur over a sustained period without affecting crop productivity. The rate is expressed in tons per acre per year.

WIND ERODIBILITY GROUP (WEG) is a grouping of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to blowing. The lower the number, the more susceptible the group is to soil blowing.

ORGANIC MATTER is the plant and animal residue in the soil at various stages of decomposition.

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WATER FEATURES TABLE

General

This table gives estimates of several important water features, which are used in conservation, land use, and areawide planning, that involve engineering considerations. Water features which are covered include hydrologic soil groups, flooding frequency and duration, and seasonal high water table.

Hydrologic Soil Groups

Soils with the same runoff potential are grouped into one of four Hydrologic Soil Groups. These groupings are used to estimate runoff from precipitation. Soils are assigned to one of four groups (see Section II-Cropland Interpretations for a detailed explanation of hydrologic soil groups).

Flooding

The temporary covering of the soil surface by flowing water, is caused by overflowing streams, by runoff from adjacent slopes, or by inflow from high tides. Shallow water standing or flowing for short periods after rainfall or snowmelt is not considered flooding. Standing water in marshes and swamps or in a closed depression is considered ponding. Frequency, duration, and probable dates of occurrence are estimated.

Frequency generally is expressed as none, rare, occasional, or frequent. *None* means that flooding is not probable. *Rare* means that it is unlikely but is possible under unusual weather conditions or after a levee failure. *Occasional* means that flooding occurs, on the average and in normal weather conditions, no more than once in 2 years. *Frequent* means that flooding occurs, on the average and under normal weather conditions, more than once in 2 years (i.e. there is a 50 percent or greater chance of flooding in any year).

Duration is typically expressed as very brief (less than 2 days), brief (2 to 7 days), long (7 to 30 days), and very long (more than 30 days).

Probable dates of occurrence that floods are most likely to occur are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

High Water Table (Seasonal)

This is a zone of saturation at the highest average depth during the wettest season. It is at least 6 inches thick, persists in the soil for more than a few weeks, and is within 6 feet of the soil surface. The depth to a seasonal high water table applies to undrained soils. The estimates are based on field observations and the evidence of a saturated zone, namely grayish colors or mottles in the soil. Soils that have a seasonal high water table are classified according to depth to the water table, kind of water table, and time of year when the water table is highest. Three kinds of seasonal high water table are recognized within the soil: apparent, perched, and artesian. Another kind is above the soil surface much of the time causing ponding.

Apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in a freshly dug, uncased borehole after adequate time is allowed for adjustments in the surrounding soil.

Perched water table is water standing above an unsaturated zone. A water table may be inferred to be perched on the basis of general knowledge of the area. To prove that a water table is perched, the water levels in boreholes must be observed to fall when the borehole is extended. In places an upper, or perched, water table is separated from a lower water table by a dry zone.

Artesian water table is one that exists under hydrostatic head, generally beneath an impermeable layer. When the impermeable layer has been penetrated by a cased borehole, the water rises.

Ponding is standing water in a closed depression. The water is removed only by percolation, transpiration, or evaporation.

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SOIL FEATURES TABLE

General

This table gives estimates of several important soil features which are used in land use planning that involves engineering considerations. Soil features which are covered include bedrock depth and hardness, cemented pan depth and hardness, subsidence, potential frost action, and risk of corrosion for uncoated steel or for concrete.

Properties

DEPTH TO BEDROCK - This value is given if bedrock is within a depth of 60 inches. The depth is based on many soil borings and observations made during soil mapping. The rock is specified as either soft or hard. If the rock is soft, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

CEMENTED PAN - Cemented pan is a nearly continuous layer of indurated or strongly cemented material having a hard, brittle consistency because the particles are held together by cementing substances such as, calcium carbonate, or oxides of silicon, iron, or aluminum. These layers are identified when they occur within a depth of 60 inches. Pans are classified as "thin" or "thick." "Thin" cemented pans are thin enough so that excavations can be made with trenching machines, backhoes, or small rippers and other equipment common to construction of pipelines, sewerlines, cemeteries, and the like. "Thick" cemented pans are sufficiently thick or massive to require blasting or special equipment beyond which is considered normal in excavating for this type of construction.

SUBSIDENCE - Subsidence potential is the maximum possible loss of surface elevation from the drainage of wet soils having organic layers or semi-fluid mineral layers. Estimates of the depth of subsidence (in inches) that takes place soon after drainage (initial subsidence) and after oxidation (total subsidence) are given for soils that are likely to subside.

POTENTIAL FROST ACTION - This is the likelihood of upward or lateral movement of soil by the formation of segregated ice lenses (frost heave) and the subsequent loss of soil strength upon thawing. The following classes are used in regions where frost action is a potential problem: (1) Low -- soils are rarely susceptible to the formation of ice lenses,

(2) Moderate -- soils are susceptible to the formation of ice lenses, resulting in frost heave and subsequent loss of soil strength, and (3) High -- soils are highly susceptible to the formation of ice lenses, resulting in frost heave and subsequent loss of soil strength.

RISK OF CORROSION - Various metals and other materials corrode when on or in the soil, and some metals and materials corrode more rapidly when in contact with specific soils than when in contact with others. Corrosivity ratings are given for two of the common structural materials, uncoated steel and concrete. The risk of corrosion classes are low, moderate, and high.

See Table 620-7 or Table 620-8 in part 620 of the *National Soils Handbook* for guides for estimating risk of corrosion for uncoated steel or concrete.

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WATER MANAGEMENT TABLE

Interpretations of soils for water management are given as limitations for pond reservoir areas, and embankments, dikes, and levees; and as restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

POND RESERVOIR AREA is the area that holds water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by the permeability and depth to fractured or permeable bedrock, or other permeable material.

EMBANKMENTS, DIKES, AND LEVEES are raised structures of soil material constructed to impound water or protect land against overflow. They generally are less than 20 feet high and are constructed of "homogeneous" soil material (without a core zone) and compacted to medium density.

DRAINAGE is the process of removing excess surface and subsurface water from agricultural land. Soil features are listed that affect grading, excavation, and stability of trench sides or ditchbanks. Features are also listed which might affect productivity after drainage is installed. The availability of drainage outlets must also be considered.

IRRIGATION is the controlled application of water to supplement rainfall for supporting plant growth. Soil features are listed that affect design, layout, construction, management, or performance of an irrigation system.

TERRACES AND DIVERSIONS are embankments or a combination of an embankment and a channel constructed across a slope to control erosion by diverting or storing surface runoff instead of permitting it to flow uninterrupted down the slope. Soil features are listed that affect the construction of terraces and diversions and that may cause problems after construction.

GRASSED WATERWAYS are natural or constructed channels that generally are broad and shallow and are covered with erosion-resistant grasses. They are used to conduct surface water to outlets at a nonerosive velocity. Soil features are listed that affect the construction and maintenance of the waterway, and also that affect the growth of grass after construction.

See the *National Soil Handbook*, Part 620, for criteria used in rating specific uses.

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IRRIGATION GUIDE

Information regarding soil intake characteristics, available water capacity, and irrigation soil tables may be found in the California NRCS Irrigation Guide.